Secondary Impacts to Groundwater From Land Application of High Organic Wastewater

Jim Janiczek
Water Bureau
DEQ

Secondary Impacts

- The presence of contaminants in groundwater, resulting from a discharge of organic waste, that are not detected in the wastewater itself.
- Primarily metals – Iron, Manganese, Arsenic.
- EDTA – Transition metals, cadmium, cobalt, copper, nickel, etc

Surface Water

Cherry Waste

Spray Irrigation

are further treated by filtration, spray irrigation and slow infiltration land application.

2. Wastewater Limitations and Monitoring Requirements

The wastewater effluent for irrigation shall be limited and monitored by the permittee as specified below. Analyses and inspections shall be conducted for the parameters listed below at least at the frequencies indicated. Reports of such monitoring shall be submitted to the Michigan Department of Natural Resources monthly in accordance with Part I, Section C-1 of this permit.

Sample/Monitoring and Location	Limitations	Measurement Frequency	Sample Type
Wastewater Effluent for Irrigation (002)*			
Flow Volume	211,000 GPD	Daily during discharge	Total Flow
Fecal Coliform Bacteria	200/100 ml as a geometric mean (maximum)	Weekly during discharge	Grab

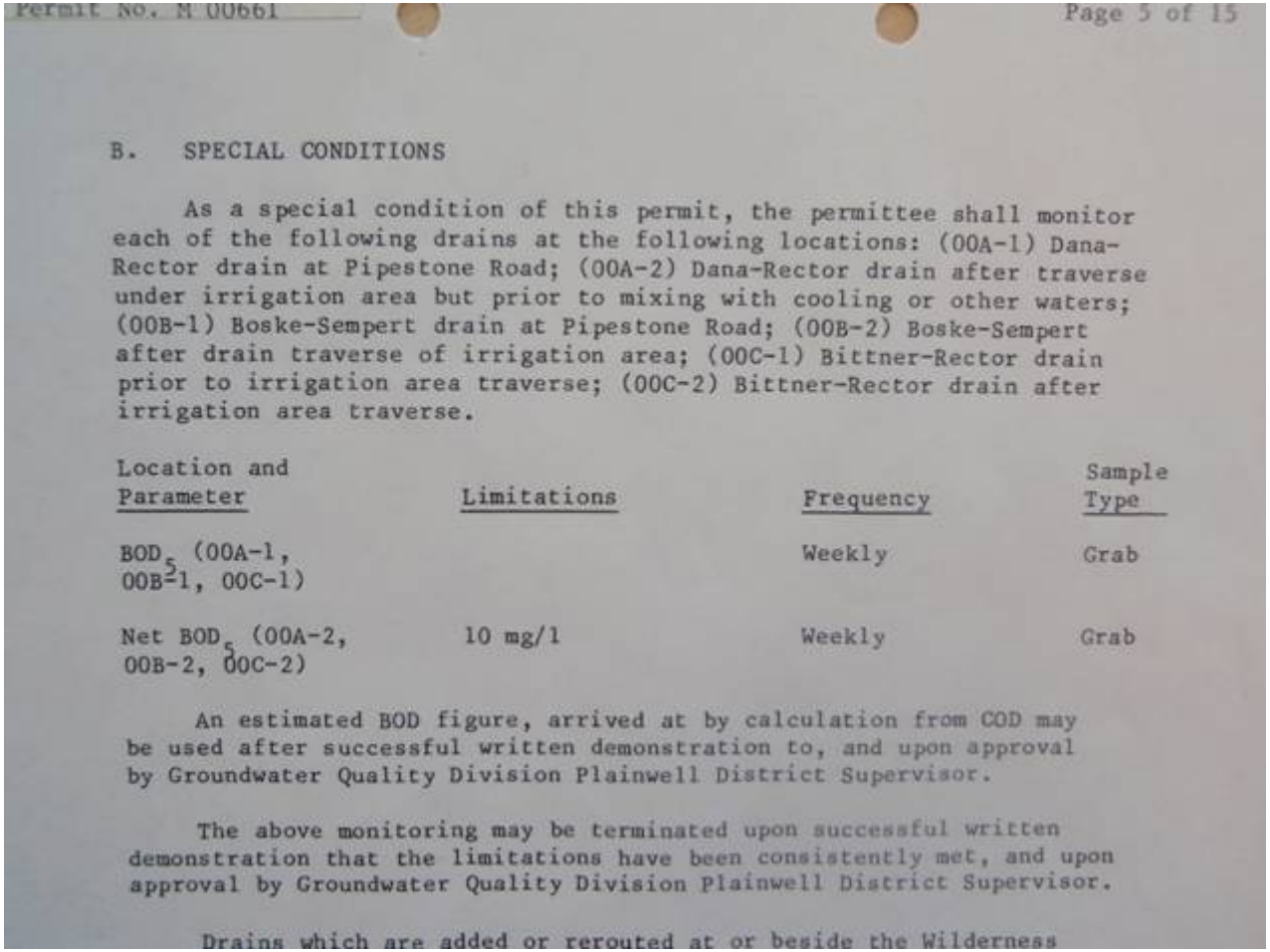
*to be measured at the pumphouse prior to spraying.

3. Irrigation Management

To assure that irrigation practices do not adversely impact groundwaters of the state or otherwise threaten public health, the following restrictions are imposed:

a. The retention ponds shall not be allowed to become anaerobic.

Special Condition



B. SPECIAL CONDITIONS

As a special condition of this permit, the permittee shall monitor each of the following drains at the following locations: (00A-1) Dana-Rector drain at Pipestone Road; (00A-2) Dana-Rector drain after traverse under irrigation area but prior to mixing with cooling or other waters; (00B-1) Boske-Sempert drain at Pipestone Road; (00B-2) Boske-Sempert after drain traverse of irrigation area; (00C-1) Bittner-Rector drain prior to irrigation area traverse; (00C-2) Bittner-Rector drain after irrigation area traverse.

Location and Parameter	Limitations	Frequency	Sample Type
BOD_5 (00A-1, 00B-1, 00C-1)		Weekly	Grab
Net BOD_5 (00A-2, 00B-2, 00C-2)	10 mg/l	Weekly	Grab

An estimated BOD figure, arrived at by calculation from COD may be used after successful written demonstration to, and upon approval by Groundwater Quality Division Plainwell District Supervisor.

The above monitoring may be terminated upon successful written demonstration that the limitations have been consistently met, and upon approval by Groundwater Quality Division Plainwell District Supervisor.

Drains which are added or rerouted at or beside the Wilderness

Effluent Monitoring

2. Wastewater Limitations and Monitoring Requirements

The effluent wastewater and the spray irrigation sites shall be limited and monitored by the permittee as specified below. Analyses and inspections shall be conducted for the parameters listed below at least at the frequencies indicated. Reports of such monitoring shall be submitted to the Michigan Department of Natural Resources in accordance with Part I, Section E-1 of this permit. The irrigation sites shall be designated Irrigation Area 1 through 5.

Sample/Monitoring and Location	Limitations	Measurement Frequency	Sample Type
Irrigation Wastewater			
Flow gpd	1,442,000 gpd (max.)	Daily	Calculation
pH	6.0-8.0 S.U.	Monthly	Grab
BOD_5	1,500 mg/l	Monthly	Grab
Chloride	250 mg/l	Monthly	Grab
Sodium, total	150 mg/l	Monthly	Grab
Total Phosphorus	5 mg/l	Monthly	Grab
Potassium		Monthly	Grab
Bicarbonate		Monthly	Grab
Chemical Oxygen Demand (COD)		Monthly	Grab
Calcium		Monthly	Grab
Magnesium		Monthly	Grab
Irrigation Areas			
Discharge Schedule: December 1 through March 1			
Hours of operation per day		Daily	Record
Application rate	1.0 in/day (max.)	Daily	Measured or Calculated
	1.5 in/week (max.)	Weekly	Measured or

Groundwater Monitoring

1. Groundwater Monitoring Requirements

All groundwater monitor wells shall be sampled and the groundwater analyzed for the parameters listed below at least at the frequencies indicated. Reports of such monitoring shall be submitted to the Michigan Department of Natural Resources quarterly in accordance with Part I, Section E-1 of this permit. The monitor wells shall be designated MWA, MWA-1, MWB, MWB-1, MWC, MWC-1, MWD, MWD1, MW1, MW3, MW5, MW5A, MW6, MW42-C and MW41-A.

PARAMETERS	FREQUENCY OF ANALYSIS	SAMPLE TYPE
Static Water Elevation	Quarterly	Reduced to USGS datum
Chemical Oxygen Demand (COD)	Quarterly	Grab
Total Organic Carbon (TOC)	Quarterly	Grab
pH	Quarterly	Grab
Chloride	Quarterly	Grab
Specific Conductance	Quarterly	Grab
Calcium	Quarterly	Grab
Sodium, total	Quarterly	Grab
Magnesium	Quarterly	Grab
Potassium	Quarterly	Grab
Sulfate	Quarterly	Grab
Bicarbonate	Quarterly	Grab
Total Phosphorus	Quarterly	Grab

Quarterly monitoring shall be done in the months of March, June, September and December.

Sand Mining

Anaerobic Bacteria

- 1987, first identification of bacteria to conduct Fe(III) reduction, *Geobacter metallireducens*
- *1989, identify anaerobic bacteria that can exist in aerobic soil conditions, Geobacter Chappelleii*

Anaerobic Bacteria

- Under anaerobic conditions, grain coating Fe(III) oxyhydroxides, and any other metal oxides bound to a soil particle, are reduced and the mobil valence of the metal goes into solution, eventually leached into groundwater.
- Without another source of oxygen, metals will move with groundwater and the concentration only reduced through dispersion.

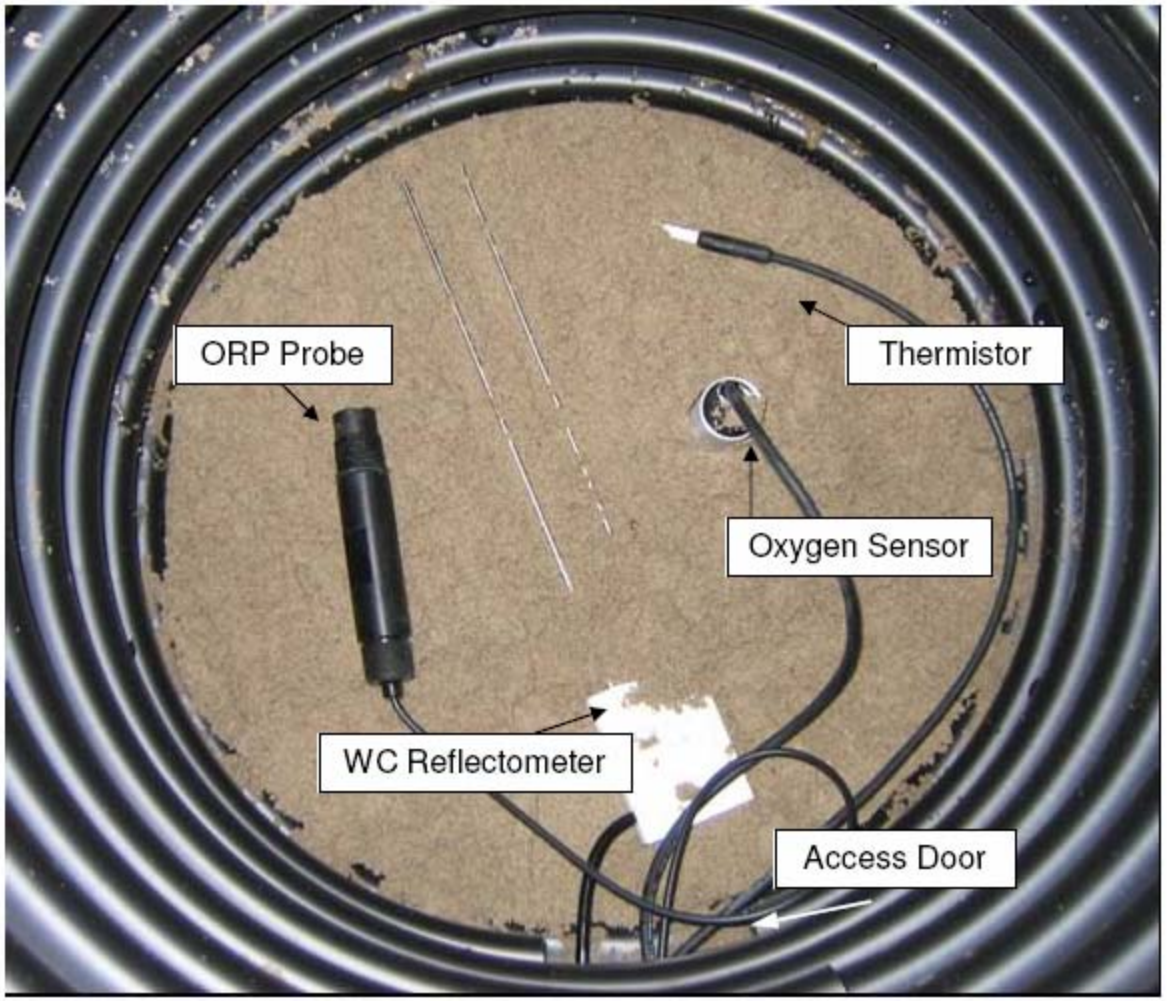
Biochemical Oxygen Demand

- Question:
- What are the key parameters, loading rate, soil type, moisture content, redox potential, etc that affect the potential for mobilizing metals.

Lab Column Study

BOD Loading (lb/ac/day)	Discharge (gal/ac/day)	Mn mg/L	Fe mg/L
Sand			
0	11,700	0	0
25	2,300	0	0
75	7,000	0	0
125	11,700	0.67	8.58
Loamy Sand			
0	11,700	0	0
25	2,300	0	0
75	7,000	0.05	0.02
125	11,700	0.45	3.92
Clay Loam			
0	11,700	0	0
25	2,300	0	0.57
75	7,000	0.03	0.06
125	11,700	0.36	0.45

MSU Soil Columns for Assimilation Capacity Study



Sensors in MSU Soil Columns

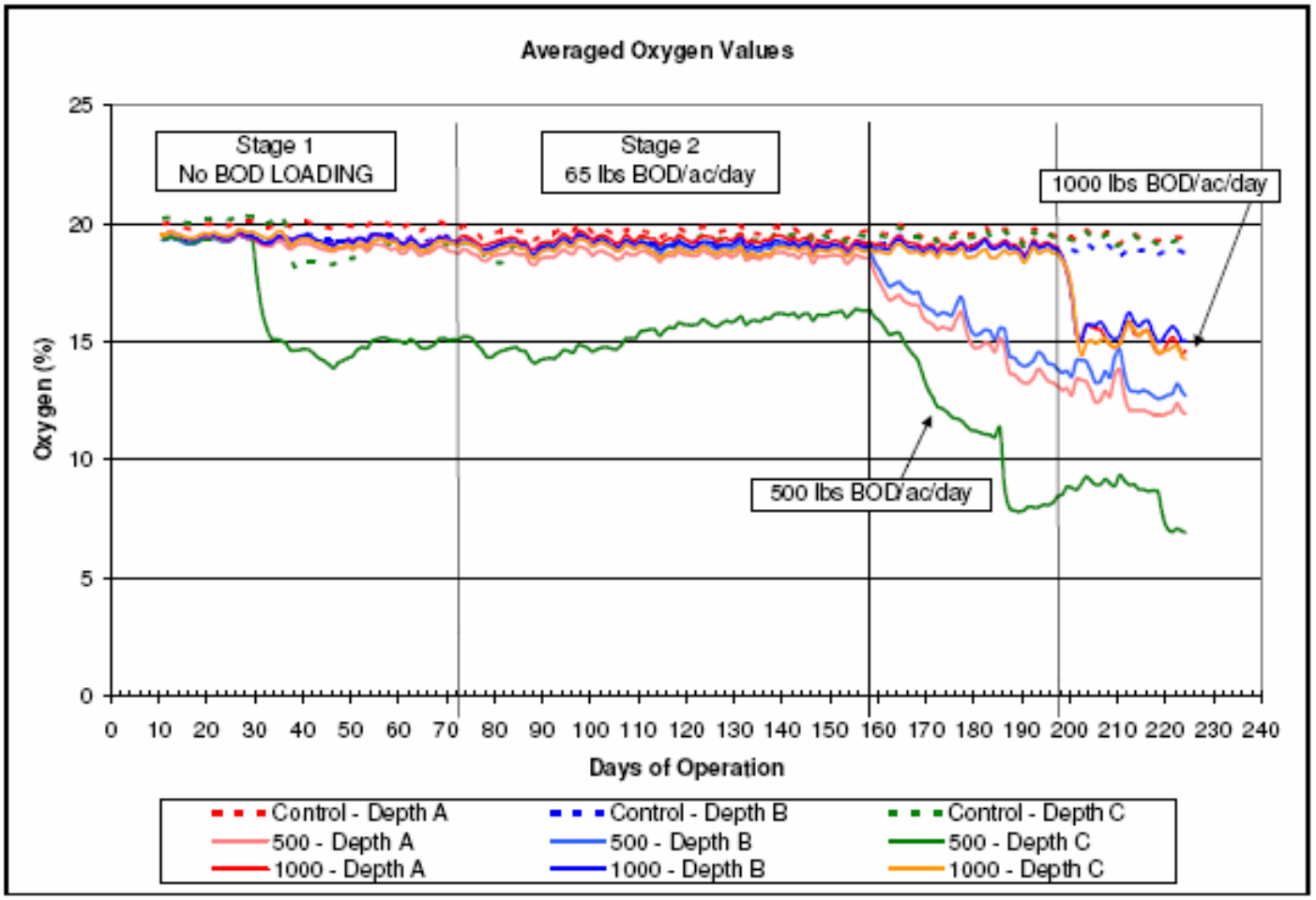


Figure 3-2. All Stages - Oxygen Level

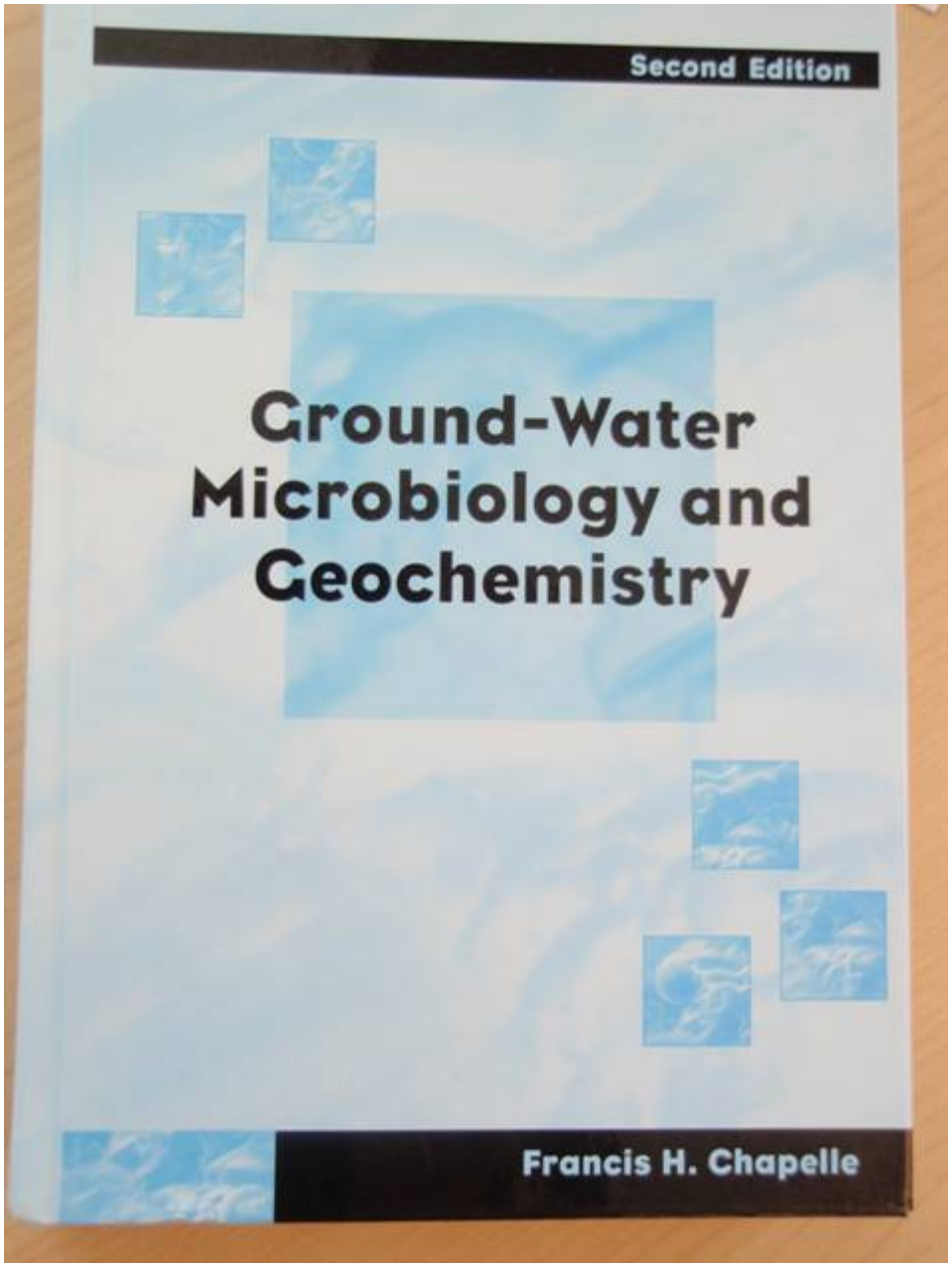
Aerated Lagoon

Anaerobic Digester

EDTA

- Ethylene diamine tetraacetic Acid
- $(HO_2CCH_2)_2NCH_2CH_2N(CH_2CO_2H)_2$.
- Metal chelating agent, used to remove scale from pipes
- Under anaerobic conditions, primarily chelates with iron and manganese
- In the presence of limited oxygen, edge of contamination plume, will bind with metals such as cadmium, chromium, cobalt, nickel, etc

Reference


Second Edition
Ground-Water Microbiology and Geochemistry
Francis H. Chapelle